Appendix J

USFWS

YCC tree restoration

Forest Management Guidelines

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Introduction

Forest management, or silviculture, is the science of tending forests to promote particular forest characteristics. These characteristics include forest composition (e.g., species diversity), structure, and growth. At the Silvio O. Conte National Fish and Wildlife Refuge (Conte Refuge), we propose to use a variety of forest management techniques to create or enhance forest habitats for priority wildlife species.

This appendix is written to provide further detail of proposed silviculture under the Comprehensive Conservation Plan (CCP) for the Conte Refuge. It includes information on the desired future condition of our forested habitats, including those areas in proposed Conservation Focus Areas (CFAs) outside the current refuge boundary where we expect to purchase land in the next 15 years. This appendix describes management techniques that may be used to meet habitat management goals and objectives.

At the end of this appendix, we provide a glossary of general forestry terms, as well as detailed descriptions of particular forest management techniques. Although there is much more to the understanding of these treatments than their definitions and nomenclature, the terminology must be understood and used carefully and precisely. The terminology in this appendix and the larger comprehensive conservation plan generally adheres to the Society of American Foresters' definitions (Helms 1998); it departs only where further clarity or precision seems warranted.

Categories of Forest Management Treatments

There are two categories of forest management treatments:

1. Regeneration treatments.

2. Tending and intermediate cutting treatments.

Regeneration treatments

Regeneration methods refer to treatments of stands and sites during the period of regeneration or establishment. The act of replacing old trees, either naturally or artificially, is called regeneration. Regeneration cuttings are made with the twin purposes of removing old trees and creating environments favorable for the establishment of regenerating trees. In truly uneven-aged stands, regeneration is almost always underway in some part of the stand.

The names of the various methods of regeneration (see glossary of silvicultural techniques below) denote the patterns of cutting in time and space that determine the structure of the stands created or maintained by the process. They distinguish between reliance on regeneration from seeds or that from sprouts and may tell a little about the degree of shading of new seedlings.

Tending or Intermediate Cutting Treatments

In contrast to regeneration treatments, tending or intermediate cutting refers to treatment at times during the rotation other than regeneration. The rotation is the period during which a single crop or generation of trees is allowed to grow. Intermediate cuttings that are aimed primarily at controlling the growth of stands by adjusting stand density or species composition are called "thinnings." Treatments conducted to regulate species composition and improve very young stands are release operations.

The glossary at the end of this appendix describes how clearcutting is associated with even-aged stands; the shelterwood method with advanced regeneration; the selection system with uneven-aged stands.

Desired Future Forest Conditions

The 15-year scope of the CCP is far shorter than the decades we expect it will take to create a diverse and mature forest. Our expectation is that much of the forest structure and species composition deemed important to our refuge focal species will take a minimum of 100 years to develop under the implementation of our forest management goals and objectives. Generally, our management will move stands towards a more ecologically mature forest structure characterized by:

- Trees that extend above the canopy.

- A vertically and horizontally diverse canopy.
- Increases in standing dead trees (snags) and downed woody debris—particularly larger size classes.
- Increases in the softwood component of mixed-species stands.
- The maintenance of a generally closed canopy.

These conditions favor refuge focal species, including but not limited to, wood thrush, blackburnian warblers, and black-throated blue warblers. Where appropriate, an even-aged management approach will benefit other focal species including Canada warbler, New England cottontail, and American woodcock. For more details, please see Appendix A.

Converting existing even-aged forests to a multi-cohort, mixed species forest over the long-term requires patient, active management of all forest age and structural classes (Kelty et al. 2003, Nyland 2003, Keeton 2006). Silvicultural approaches will differ by habitat types within the forest, but all efforts will respect the capability of a given site to grow certain tree species (e.g. based on soil properties, moisture regimes, elevation, and aspect). Where feasible and assuming favorable site capabilities, our management strategies will predominately favor promotion of uneven-aged, mixed species stands which we believe will best achieve our habitat goals and objectives. There are some sites, however, where techniques to promote even-aged stands would better meet our objectives. This may occur, for example, in stands where we want to encourage advanced regeneration of spruce-fir, enhance deer wintering areas, and/or to manage for American woodcock and Canada warbler.

Our draft CCP Goal 1: Wildlife and Habitat Conservation reads:

> *Promote the biological diversity, integrity, and resiliency of terrestrial and aquatic ecosystems within the Connecticut River watershed in an amount and distribution that sustains ecological function, supports healthy populations of native fish and wildlife, especially those of conservation concern, and anticipates the effects of climate and land use changes.*

Our management efforts will focus on providing sustainable high quality habitat conditions for our focal species. As noted above, in order to accomplish this, we will need to manage the various size classes and structures to ensure habitat conditions can be provided over the long-term. Not every acre on the refuge is forested, nor is every forested acre suitable for active management. Furthermore, not every forested acre on refuge land is adequately stocked as many parcels of land purchased by the refuge have been recently harvested. In these areas, very little, or no, management may be warranted to meet our habitat and focal species objectives during the 15-year lifetime of this plan.

List of Guidelines and Best Management Practices

At a minimum, our forest management will adhere to recommended best management practices for forest and wildlife management listed in the documents below:

- Calhoun, A.J.K. and P. deMaynadier. 2003. Forestry habitat management guidelines for vernal pool wildlife in Maine. U.S. Environmental Protection Agency, Boston, MA.
- Chase, V., L. Deming and F. Latawiec. 1997. Buffers for wetlands and surface waters: a guidebook for New Hampshire municipalities. Audubon Society of New Hampshire.
- Cullen, J.B. 2000. Best management practices for erosion control on timber harvesting operations in New Hampshire. NH Dept. of Resources and Economic Development, Division of Forests and Lands, Forest Information and Planning Bureau and University of New Hampshire Cooperative Extension.
- Bennett, Karen P. editor. 2010. Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire (second edition). University of New Hampshire Cooperative Extension, Durham, New Hampshire. Accessed online April 2015 at: *http://www.goodforestry.org.*
- Reay, R.S., D.W. Blodgett, B.S. Burns, S.J. Weber, and T. Frey. 1990. Management guide for deer wintering areas in Vermont. Vermont Department of Forests, Parks, and Recreation and Department of Fish and Wildlife.
- Smith, S. and S. Whitney. 2001. Guide to New Hampshire timber harvesting laws. University of New Hampshire Cooperative Extension.

Identifying Habitat Management Units

To facilitate the development of detailed habitat management plans (HMP), we plan to divide all refuge lands currently under fee ownership into geographic areas or habitat management units (HMUs). The HMP, which is a step-down plan to be completed upon CCP approval, will detail stand-level treatments and prescriptions (e.g., timing, distribution, method or technique, etc.) for each HMU within a given CFA. Our HMU boundaries are defined based on ecological systems and landscape features such as roads, waterways, and logistical considerations.

Proposed Management by Forest Habitat Type

The following proposed management may be employed by the refuge during implementation of the approved CCP to achieve the desired future condition over the long-term. It includes commercial and non-commercial forest management designed to meet our focal species habitat requirements. We have broken down our descriptions of management by uneven-aged and even-aged techniques. Even-aged techniques result in stands with trees that are all generally the same age and size, while uneven-aged techniques promote forests with a greater diversity of ages and sizes of tress. These descriptions represent anticipated management. For more detailed habitat-specific management discussion please see appendix A. More detailed prescriptions by treatment unit will be developed in the HMPs and will be based on individual site conditions.

Spruce-fir Stands

Our desired future conditions for spruce-fir stands on the refuge to benefit focal species include:

- At the stand-level, improved vertical and horizontal diversity in canopy layers while maintaining a generally closed canopy.
- Gaps should retain structural diversity in the form of standing snags.

Uneven-aged Management

Uneven-aged management techniques will be adapted to convert the refuge's even-aged spruce-fir stands to a more diverse structure. As site conditions dictate, we plan to conduct harvest using a combination of group selection, with some single-tree selection between groups. Groups will vary in size depending on our goals and site conditions, but will generally be 1/10 acre in size and will be distributed throughout the management unit with 10 to 15 percent of the area being removed on 15- to 20-year cycles. Residual basal area (BA) goals in spruce-fir stands are approximately 80 square feet per acre with 50 percent in 6- to 10-inch diameter class; 30 percent in 11- to 14-inch diameter class; and 25 percent in a 15-inch or greater diameter class.

During each harvest entry individual trees will be identified–approximately 6 trees per acre–for retention to ecological maturity. These trees will add an important wildlife habitat component in the form of snags and eventually coarse woody debris. Our efforts will focus on retaining trees across all size classes with a particular emphasis on allowing larger diameter trees to reach ecological maturity.

Even-aged Management

In certain areas, for instance where there is healthy, advanced spruce-fir regeneration, or in critical deer wintering areas, we may employ even-aged management techniques. This is consistent with our objective to perpetuate a multi-aged and multi-structured forest at the landscape-scale. We would conduct harvests using shelterwood or clearcuts to develop a mosaic pattern that will result in a progressive patch, block, or strip system, wherein typically 15 percent of the area is harvested in 15- to 20-year intervals.

Target rotation age is 80 to130 years and will vary by species composition (for example, balsam fir dominated stands may have shorter rotation ages) and site conditions. Assuming a 15-year harvest cycle and an approximate 100-year rotation, this equates to roughly six age classes with 33.3 percent of the area treated with even-aged techniques in a 0- to 30-year age class, 33.3 percent in a 30- to 60-year age class, and 33.3 percent in a 60- to100-year age class. If no significant natural disturbance occurs during the rotation of a treatment area, BA at the time of harvest will likely be above 140 square feet per acre, and may be in excess of 200 square feet per acre.

Snag and cavity trees will need to be retained in group openings in each harvest. We estimate retention of approximately 7 square feet per acre (e.g. approximately 6 trees per acre) to account for our snag and cavity tree requirements. Habitat improvement may need to be employed on adjacent areas to account for potential loss of this component from sudden exposure to sun, wind, storm, insect, or other natural agents.

Mixed-species Stands

Our desired future conditions for mixed-species stands on the refuge to benefit focal species include:

- At the stand-level, improved vertical and horizontal diversity in canopy layers while maintaining a general closed canopy.
- Gaps should favor softwood regeneration and retain structural diversity in the form of standing snags.

These stands contain a species mixture that includes softwood and hardwood tree species. Silvicultural approaches will vary within the different mixed-species forest types found on the refuge based largely on the capability of a site (e.g., based on soil properties, moisture regimes, elevation, aspect, etc.) to grow a predominance of either softwood species (e.g., spruce, fir, hemlock, pine) or hardwoods (e.g., northern hardwoods or oak). Where feasible, and assuming favorable site capability, management strategies will favor or increase the softwood component of stands.

Uneven-aged Management

Uneven-aged management techniques will be adapted to convert the refuge's largely even-aged mixed-species stands to a more diverse structure. As site conditions dictate, we plan to conduct harvests using a combination of group selection, with some single-tree selection between groups. Groups will vary in size depending on our goals and site capabilities, but will generally be 1/10 acre in size and will be distributed throughout the management unit with 10 to 15 percent of the area being removed on 15- to 20-year cycles. Residual BA goals in mixed species stands will vary with site conditions but will generally approach 100 feet^2/acre with roughly 42 percent in a 6 to 10" diameter class, 28 percent in 11 to 14" diameter class, and 30 percent in a 15" or greater diameter class.

During each harvest entry individual trees will be identified–approximately 6 trees/acre–for retention to ecological maturity. These trees will add an important habitat component in the form of snags and eventually coarse woody debris. Our efforts will focus on retaining trees across all size classes with a particular emphasis on allowing larger diameter trees to reach ecological maturity.

Even-aged management

Where site conditions and management goals deem appropriate (e.g., deer wintering areas and areas where advanced softwood regeneration exists) we may employ even-aged management techniques as described for softwood management (Frank and Bjorkbom 1973). These techniques will be used to perpetuate a multi-aged and multi-structured forest landscape through even-aged area regulation. We plan to conduct harvests utilizing shelterwood or clearcuts in a mosaic pattern that will result in a progressive patch, block, or strip system, wherein 15 percent of the area is harvested in 15- to 20-year intervals.

Hardwood Stands

Our desired future conditions for hardwood stands on the refuge to benefit focal species include:

- At the stand-level, improved vertical and horizontal diversity in canopy layers while maintaining a general closed canopy.
- Gaps should retain elements of structural diversity in the form of standing snags and be sized to favor diverse regeneration of tolerant mid-tolerant species.

Uneven-aged Management

Uneven-aged management techniques will be adapted to convert the refuge's even-aged hardwood stands to a more diverse structure. As site conditions dictate, we plan to conduct harvests utilizing a combination of group selection with some single tree selection between groups. Groups will vary in size depending on our goals, but will generally be approximately 1/10 acre in size (larger groups will be used to regenerate shade-intolerant species) and will be distributed throughout the entire management unit with 10 to 15 percent of the area being removed on 15- to 20-year cycles. BA goals in northern hardwoods should strive for a minimum of 70 square feet per acre with roughly 42 percent in a 6- to 10-inch diameter class, 28 percent in 11- to 14-inch diameter class, and 30 percent in a 15-inch or greater diameter class.

During each harvest entry individual trees will be identified–approximately 6 trees per acre–for retention to ecological maturity. These trees will add an important habitat component in the form of snags and eventually coarse woody debris. Our efforts will focus on retaining trees across all size classes with a particular emphasis on allowing larger diameter trees to reach ecological maturity.

Woodcock Focus Areas

Even-aged Management

In focus areas identified for woodcock or New England cottontail, we will use accepted silvicultural practices, including clearcuts and patch cuts, to:

- Create openings.
- Promote understory development.
- Sustain early successional habitat.

Some larger roosting fields may also be maintained. Cutting cycles will be approximately 8 to 10 years on a 40-year rotation. Some openings may be permanently maintained, primarily by mowing and brush clearing using mechanized equipment. We will perpetuate existing examples of the aspen-birch community in size classes appropriate for American woodcock.

Anticipated Management on Lands to be Acquired in the Proposed Conservation Focus Areas

Over the next 15 years, as land is acquired from willing sellers in CFAs, we will evaluate lands for potential management opportunities. We will initiate a new HMP and undertake the same evaluation we conducted for current refuge lands as acquisitions, budgets, and staffing allow. Within 2 years of land acquisition, we will conduct a stand inventory and divide the ownership into management units. We will then develop management prescriptions to support the same goals and objectives for our focal species, using the same methodology we described above for current refuge lands.

Citations

Frank, R.M., and J.C. Bjorkbom. 1973. A silvicultural guide for spruce-fir in the northeast. Page 29. General Technical Report, U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, Upper Darby, PA.

Helms, J.A. 1998. The Dictionary of Forestry. Society of American Foresters, Bethesda, MD.

Keeton, W.S. 2006. Managing for late-successional/old-growth characteristics in northern hardwood-conifer forests. Forest Ecology and Management 235:129–142.

Kelty, M.J., D.B. Kittredge Jr., T. Kyker-Snowman, and A.D. Leighton. 2003. The conversion of even-aged stands to uneven-aged structure in southern New England. Northern Journal of Applied Forestry 20:109–116.

Leak, W.B., D.S. Solomon, and P.S. DeBald. 1986. Silvicultural guide for northern hardwood types in the Northeast (revised). Page 40. Research Paper, U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, Broomall, PA.

Nyland, R.D. 2003. Even- to uneven-aged: the challenges of conversion. Forest Ecology and Management 172:291–300.

Glossary

Definitions of General Forest Silvicultural Terms

Basal area: Basal area is the total cross-sectional area of all stems in a stand measured at breast height (4.5 feet above the ground) and expressed as a per unit of land area (typically square feet per acre).

Canopy: The profile of the top of the stand; the amount of cover provided by leaves in the layers of a forest stand.

Coarse woody debris: Any piece of dead woody material, such as dead tree trunks, limbs, large root masses, and logs on the ground or in streams. Coarse woody debris provides important habitat for many wildlife species.

Even-aged stands versus uneven-aged stands: Regenerative disturbances, whether naturally or artificially induced, determine when new trees appear or start active development on any given area of ground. Each aggregation of trees that starts as a result of a single disturbance is a single cohort. If the range of ages of trees within the cohort is very narrow, the new aggregation is regarded as a single age class which is also even-aged. Slightly more complicated are stands that start from so-called advanced regeneration that is already in place before the old stand is removed. An uneven-aged stand or multiple-cohort stand contains at least three age classes intermingled intimately on the same area and much more complicated developmental patterns. Mixed stands have more than one tree species, and the interaction between them makes their development even more complicated, especially if they also have more than a single age-class of trees. When identifying age classes, the profile of the top of the stand (canopy) is a good criterion because trees of the same age grow in height at roughly the same rate, provided site conditions are uniform. An even-aged stand tends to be almost smooth on top. An uneven-aged stand is distinctly irregular in height; the greater the number of age classes or cohorts, the more uneven the canopy.

Hardwoods stand: A forest stand dominated by deciduous trees, such as oaks, maples, beeches, etc.

Mixed-species stand: A forest stand with two or more predominate species.

Silviculture: Silviculture has been variously defined as the art of producing and tending a forest; the application of knowledge of silvics in the treatment of a forest; or the theory and practice of controlling forest establishment, composition, structure, and growth. Since silvicultural practice is applied forest ecology, it is also a major part of the biological technology that carries ecosystem management into action. Silviculture is the oldest conscious application of the science of ecology and is a field that was recognized before the term ecology was coined. Silvicultural practice encompasses all treatments applied to forest vegetation.

Stand: A forest stand is a contiguous group of trees, sufficiently uniform in species composition, arrangement of age-classes, site quality, and condition to be a distinguishable unit. The internal structure of a stands varies mainly with respect to the degree that different species and age classes are intermingled. The range of complexity can extend to a wide variety of combinations of age classes and species in various vertical and horizontal arrangements.

Snags: A standing dead tree from which the leaves and most of the branches have fallen off; can provide important wildlife habitat, particularly for nesting, denning, and/or foraging.

Softwood stand: A forest stand dominated by conifer species, such as spruce, fir, hemlock, and pine.

Shade-tolerant versus shade-intolerant: Shade-tolerant tree species are able to compete to survive under shaded conditions; sometimes also referred to just as tolerant. Conversly, shade-intolerant species are able to compete to survive under direct sunlight conditions.

Definitions/Descriptions of Forest Silvicultural Techniques and Methods to Use in our Forest Management for Focal Species

Group Selection: This technique involves the removal of small groups of trees throughout a stand, to initiate and/or maintain an uneven-aged forest. A group selection opening is considered to be less than, or equal to, twice the height of the adjacent mature trees. This method will encourage regeneration of intermediately tolerant and tolerant species, but some intolerant species can appear towards the center of the harvest areas when the groups are at the maximum size. The likelihood of the harvest areas regenerating combined with the ability to schedule continual harvest entries, results in this technique being a method of choice to convert even-aged stands to uneven-aged stands when desired.

Group selection results in moderately- closed to closed-canopy conditions. Regeneration and shrubby vegetation can be expected to develop with reasonable assurance. This technique can be used in combination with single-tree selection to ensure canopy closure requirements meet desired conditions. Priority species such as the blackburnian warbler, rusty blackbird, and Canada warbler will benefit from the application of this technique in a conifer-dominated habitat area. The predominantly closed canopy condition resulting from this technique will also benefit deer winter cover areas. The technique can be applied in all habitat types. Its application in the refuge's

spruce-fir forest most closely resembles the natural disturbance that would be expected to take place if the area were allowed to develop without manipulation.

Single Tree Selection: This technique involves the removal of individual trees throughout a stand. Use of this technique, on a continual harvesting cycle, is considered uneven-aged management. It can also be used during even-aged management, and when done so, is commonly referred to as an intermediate thinning. In uneven-aged management, it is used to introduce small openings in the canopy by focusing the harvest on dominant, older aged trees. In even-aged management, it is used to promote the quality and growth of the remaining trees by focusing the harvest on poor quality, low vigor trees. The technique will likely result in varying quantities of regeneration of mostly shade tolerant species.

Single tree selection results in a relatively closed canopy condition. Understory development is usually minimal. Single tree selection creates little opportunity to release or create regeneration. Canopy openings are small and any growing space created by the removal of single trees is quickly utilized by the crowns of adjacent canopy dominant trees. This technique is often used in combination with group selection to ensure regeneration is established and separate age classes are created to perpetuate the overall desired condition. In using single tree selection, with even-aged objectives in the form of a thinning, it will likely result in less opportunity for regeneration and understory development. Often times the suppressed and co-dominant trees are selected for removal resulting in very little change in canopy closure after a treatment. This technique can be applied in all habitat types.

Pre-commercial Stand Treatments to Improve Habitat Conditions: These treatments include entering an even- or uneven-aged stand at any stage of development with the intent of tending to habitat needs through non-commercial thinning, weeding, cleaning, liberation, sanitation, or other improvement methods. This technique can be used to control species composition and reduce an overabundance of stems per acre to a more desired stocking level. This can be applied through thinning young stands (pre-commercially) to control species composition, conducting intermediate thinnings in middle aged stands to maintain accelerated growth and remove unwanted vegetation, and prescribed fire. This technique may also be used to control stocking levels of habitat features such as snag trees, cavity trees, den trees, downed wood and other features through girdling, felling, boring, or other techniques.

This habitat improvement technique is varied in its application, but overall should be applied to alter or enhance young stands and introduce or reduce habitat features when goals and objectives are not being met. This can be applied in all habitat types and may be extended to areas that are not capable of supporting equipment for larger scale manipulation efforts.

Shelterwood System: This technique involves a series of harvests carried out with the intent of regenerating a stand utilizing mature trees that are removed at the end of the scheduled rotation. The overstory is removed in stages and the well-developed underlying regeneration then becomes the stand. This technique is typically used to regenerate intermediately tolerant (mid-successional) and tolerant (late successional) species, but in certain instances can be used for intolerant (early successional) species. Use of this technique is considered even-aged management, although variations more often found in the irregular shelterwood system can result in a multi-aged stand. In order for a shelterwood system to be considered, a stand should be reasonably well stocked with a moderate to high component of the species desired for regeneration.

A number of shelterwood system applications exist. The more commonly used is the open shelterwood system. Although less commonly used, the dense shelterwood, deferred shelterwood, irregular shelterwood, natural shelterwood, and nurse tree shelterwood systems are useful in accomplishing specific regenerative needs as well as other resource management objectives.

Shelterwood variations allow a variety of habitat conditions to be created while fulfilling the regenerative objectives of the technique. Irregular shelterwood systems are being used to convert even-aged or degraded stands to a more structurally diverse condition. It can be used to create a dense crown closure when connectivity of an older age forest needs to be maintained. The amount of time needed to establish regeneration and conduct the overstory removal can provide enough time for other areas to develop into an older age condition, and ensure refuge goals are being met continually. Overstory removal can be delayed through an irregular shelterwood if further development of other areas is necessary. It can also be used to create a more open crown closure when development of a shrub component in the understory is desired or residual tree are needed to meet specific habitat

requirements. Once regenerative needs have been reached and the "shelter" (seed) trees have been removed, the new stand can then be managed for structural objectives as it develops. Overstory removal can result in a regenerative condition which does offer some early successional benefits as described in the clearcut technique.

This technique can be used in all habitat types. Its application on habitats comprised of predominately shallow rooted species (e.g. red spruce/balsam fir) or wet soil conditions, does introduce a greater susceptibility of the residual trees to windthrow from wind events.

Clearcutting: This technique involves the removal of an entire stand of trees in one cutting to obtain natural reproduction. Two common methods of clearcutting are patch or block clearcuts, and strip clearcuts. This regeneration technique is considered to be even-aged management, although somewhat coarse multi-aged stands can be developed through progressive patch or progressive strip clearcut systems. Clearcut size affects the species mixtures that regenerate. As clearcuts increase in size, they tend to favor shade intolerant regeneration. As they become smaller they gravitate towards encouraging intermediately tolerant and tolerant species.

Clearcuts are often used to create an early successional habitat condition. Early successional habitat is when an area is in a young, shrubby, regenerating condition that covers an area large enough to be recognized and perhaps utilized by wildlife or plants associated with such an open or no-canopy condition.

This technique should be utilized when an early successional habitat condition is desired and found to be lacking or not available within the landscape. As mentioned previously in this description, clearcut size does have an impact on tree species composition, and therefore should also be utilized when current species composition is not desired or diverse enough to reach goals and objectives. This technique can be used in all habitat types, and although somewhat limiting in terms of emulating natural processes or conditions, can be used in a continual, progressive system that sustains multiple age classes through a coarse uneven-aged landscape perspective.